

1 WE CLAIM:

- 2 1. A method of manufacturing an electronic device from a structure comprising at least one
3 layer of device material sandwiched between a first layer of metal and a second layer of
4 metal, comprising the steps of:
5 forming a first aperture through the first layer of metal, the second layer of metal and the
6 device material,
7 applying a first layer of insulating material to the first metal layer,
8 insulating the walls of the first aperture,
9 providing a third metal layer on the first layer of insulating material,
10 forming a second aperture within the region defined by the first aperture,
11 providing a first electrical interconnection between the top and bottom surfaces of the
12 through the second aperture,
13 creating an electrical interconnection between the third metal layer and the first metal layer,
14 selectively removing metal from the third metal layer to define first and second electrode
15 areas, wherein the first terminal includes the electrical interconnection created between the
16 third metal layer and the first metal layer and the second terminal includes the plated
17 second aperture.
- 18 2. A method of manufacturing a device according to claim 1, wherein said step of insulating
19 the walls of the first aperture is performed at least in part by the step of applying the first
20 layer of insulating material to the first metal layer,
- 21 3. A method of manufacturing a device according to claim 1, comprising the further steps of:
22 applying a second layer of insulating material on the second metal layer, and
23 providing a fourth metal layer on the second layer of insulating material in advance of
24 forming the second aperture.
- 25 4. A method of manufacturing a device according to claim 3, wherein said step of insulating
26 the walls of the first aperture is performed at least in part by the step of applying the second
27 layer of insulating material to the first metal layer,

- 1 5. A method of manufacturing a device according to claim 4, comprising the further steps of:
2 forming a third aperture, in advance of the application of the insulating layers, through the
3 first metal layer, second metal layer and the at least one layer of device material,
4 forming a fourth aperture within the region defined by the third aperture, and
5 plating the fourth aperture to provide a second electrical interconnection between the top
6 and bottom surfaces of the device.
- 7 6. A method of manufacturing a device according to claim 5, comprising the additional step of
8 selectively removing material from the fourth metal layer to define third and fourth
9 terminals.
- 10 7. A method of manufacturing a device according to claim 1, wherein the first and third
11 apertures are formed at opposing ends of the device.
- 12 8. A method of manufacturing a device according to claim 1, further comprising the initial
13 step of defining singulation references in the first and second layers of metal.
- 14 9. A method of manufacturing a device according to claim 1, wherein the steps of applying a
15 first layer of insulating material to the first metal layer and providing a third metal layer on
16 the first layer of insulating material are performed in a single step by the application of a
17 resin clad metal.
- 18 10. A method of manufacturing a device according to claim 9, wherein said resin clad metal is
19 copper.
- 20 11. A method of manufacturing a device according to claim 5, wherein the steps of applying a
21 second layer of insulating material to the second metal layer and providing a fourth metal
22 layer on the second layer of insulating material are performed in a single step by the
23 application of a resin clad metal.
- 24 12. A method of manufacturing a device according to claim 11, wherein said resin clad metal is
25 copper.
- 26 13. A method of manufacturing a device according to claim 12, wherein said structure
27 comprising at least one layer of device material sandwiched between a first layer of metal

1 and a second layer of metal is a multi layer structure comprising alternating layers of device
2 material and metal.

3 14. A method of manufacturing a device according to claim 1, wherein the device is a PTC
4 device and the device material is a PTC material.

5 15. A method of manufacturing a device according to claim 1, wherein said structure
6 comprising at least one layer of device material sandwiched between a first layer of metal
7 and a second layer of metal is provided as a laminated sheet.

8 16. An electronic device comprising:
9 a first metal layer,
10 a second metal layer
11 at least one layer of device material sandwiched between the first metal layer and the
12 second metal layer which function as electrodes for the device material,
13 a first terminal for providing a first electrical connection to the device,
14 a second terminal for providing a second electrical connection to the device,
15 wherein the first terminal is electrically connected to the first metal layer and the second
16 terminal is insulated from the first metal layer and electrically connected to the second
17 metal layer by a conductive channel which passes through and is insulated from the first
18 metal layer and device material.

19 17. A device according to claim 16, wherein the conductive channel comprises a metal plated
20 channel.

21 18. A device according to claim 16, wherein the second terminal is insulated from the first
22 metal layer by a first layer of insulating material.

23 19. A device according to claim 18, wherein said first layer of insulating material substantially
24 covers said first layer of metal.

25 20. A device according to claim 18, comprising a third layer of metal disposed on the first layer
26 of insulating material and where said third layer is divided by an isolation area to provide
27 the first terminal and the second terminal.

- 1 21. A device according to claims 16, further comprising
2 a third terminal for providing a third electrical connection to the device,
3 a fourth terminal for providing a fourth electrical connection to the device,
4 wherein the fourth terminal is electrically connected to the second metal layer and the third
5 terminal is insulated from the second metal layer and electrically connected to the first
6 metal layer by a second conductive channel which passes through and is insulated from the
7 second metal layer and device material.
- 8 22. A device according to claim 21, wherein the second conductive channel comprises a metal
9 plated channel.
- 10 23. A device according to claim 21, wherein the second terminal is insulated from the second
11 metal layer by a second layer of insulating material.
- 12 24. A device according to claim 23, wherein said second layer of insulating material
13 substantially covers said second layer of metal.
- 14 25. A device according to claim 24, wherein the fourth terminal is electrically connected to the
15 second metal layer by an interconnect formed through said second layer of insulating
16 material.
- 17 26. A device according to claim 21, wherein the second conductive channel is provided at one
18 end of the device.
- 19 27. The device of claim 26, wherein the first conductive channel and second conductive
20 channel are located at opposing ends of the device.
- 21 28. The device of claim 16, wherein the first conductive channel is located at one end of the
22 device.
- 23 29. A device according to claim 16, wherein said terminals are plated.
- 24 30. A device according to claim 29, wherein said terminals are plated with nickel, copper
25 and/or gold.

1 31. A device according claim 16, wherein said insulating material comprises a cured resin.

2 32. A device according to claim 16, wherein said at least one layer of device material comprises
3 alternating layers of device material and metal.

4 33. A device according to claims 16, wherein said device is a PTC device and said device
5 material is a PTC material.

6 34. A PTC device comprising:

7 a first metal layer,

8 a second metal layer

9 at least one layer of PTC material sandwiched between the first metal layer and the second
10 metal layer,

11 a first terminal for providing a first electrical connection to the device,

12 a second terminal for providing a second electrical connection to the device,

13 wherein the first terminal is electrically connected to the first metal layer and the second
14 terminal is electrically connected to the second metal layer by a conductive channel which
15 passes through and is insulated from the first metal layer and the at least one layer of PTC
16 material.

17 35. A method of manufacturing a matrix of electronic devices from a structure comprising at
18 least one layer of device material sandwiched between a first layer of metal and a second
19 layer of metal, comprising the steps of:

20 forming a first array of apertures through the first layer of metal, the second layer of metal
21 and the device material,

22 applying a first layer of insulating material to the first metal layer,

23 insulating the walls of the first array of apertures,

24 providing a third metal layer on the first layer of insulating material,

25 forming a second array of apertures such that each aperture of the second array is

26 positioned within the region defined by an aperture from the first array of apertures,

27 providing electrical interconnections between the top and bottom surfaces of the matrix

28 through the second array of apertures to create electrical interconnections between the third

29 metal layer and the first metal layer,

1 selectively removing metal from the third metal layer to define first and second terminals
2 for each device of the matrix, wherein each first terminal includes an electrical
3 interconnection between the third metal layer and the first metal layer and each second
4 terminal includes an insulated electrical interconnection between the top and bottom
5 surfaces of the device.

6 36. A method of manufacturing a matrix of electronic devices according to claim 35, wherein
7 said step of insulating the walls of the first array of apertures is performed at least in part by
8 the step of applying the first layer of insulating material to the first metal layer,

9 37. A method of manufacturing a matrix of electronic devices according to claim 35,
10 comprising the further steps of:
11 applying a second layer of insulating material on the second metal layer, and
12 providing a fourth metal layer on the second layer of insulating material in advance of
13 forming the second array of apertures.

14 38. A method of manufacturing a matrix of electronic devices according to claim 37, wherein
15 said step of insulating the walls of the first array of apertures is performed at least in part by
16 the step of applying the second layer of insulating material to the first metal layer.

17 39. A method of manufacturing a matrix of electronic devices according to claim 38,
18 comprising the further steps of:
19 forming a third array of apertures, in advance of the application of the insulating layers,
20 through the first metal layer, second metal layer and the at least one layer of device
21 material,
22 forming a fourth array of apertures within the region defined by the third array of apertures,
23 and
24 providing electrical interconnections between the top and bottom surfaces of the device
25 through the fourth array of apertures.

26 40. A method of manufacturing a matrix of electronic devices according to claim 40,
27 comprising the additional step of selectively removing material from the fourth metal layer
28 to define third and fourth terminals for individual devices in the matrix.

- 1 41. A method of manufacturing a matrix of electronic devices according to claim 35, wherein
2 each of the first array of apertures and each corresponding aperture of the third array of
3 apertures are formed on opposing ends of the individual devices within the matrix.
- 4 42. A method of manufacturing a matrix of electronic devices according to claim 35, further
5 comprising the initial step of defining singulation references in the first and second layers
6 of metal.
- 7 43. A method of manufacturing a matrix of electronic devices according to claim 35, wherein
8 the steps of applying a first layer of insulating material to the first metal layer and providing
9 a third metal layer on the first layer of insulating material are performed in a single step by
10 the application of a resin clad metal.
- 11 44. A method of manufacturing a matrix of electronic devices according to claim 43, wherein
12 the metal of said resin clad metal is copper.
- 13 45. A method of manufacturing a matrix of electronic devices according to claim 40, wherein
14 the steps of applying a second layer of insulating material to the second metal layer and
15 providing a fourth metal layer on the second layer of insulating material are performed in a
16 single step by the application of a resin clad metal.
- 17 46. A method of manufacturing a matrix of electronic devices according to claim 45, wherein
18 the metal of said resin clad metal is copper.
- 19 47. A method of manufacturing a matrix of electronic devices according to claim 35, wherein
20 said structure comprising at least one layer of device material sandwiched between a first
21 layer of metal and a second layer of metal is a multi layer structure comprising alternating
22 layers of device material and layers of metal.
- 23 48. A method of manufacturing a matrix of electronic devices according to claim 35, wherein
24 the device is a PTC device and the device material is a PTC material.
- 25 49. A method of manufacturing a matrix of electronic devices according to claim 40,
26 comprising the additional step of joining a second matching matrix of electronic devices to

1 the matrix such that terminals of adjoining faces of each matrix are aligned and electrically
2 connected.

3 50. A method of manufacturing a matrix of electronic devices according to claim 35
4 comprising the further step of singulation of devices.

5 51. A method of manufacturing a matrix of electronic devices according to claim 50 wherein
6 the step of singulation groups two or more devices together as individual devices.

7 52. A method of manufacturing a matrix of electronic devices according to claim 50 wherein
8 said individual devices are configured as SIP packages.

9 53. A method of manufacturing a matrix of electronic devices according to claim 50 wherein
10 said individual devices are configured as DIP packages.

11 54. A method of manufacturing a matrix of electronic devices according to claim 50, wherein
12 the device material is a dielectric material.

13 55. A matrix of electronic devices comprising:

14 a first metal layer,

15 a second metal layer

16 at least one layer of device material sandwiched between the first metal layer and the
17 second metal layer which function as electrodes for the device material,

18 a first array of terminals for providing electrical connections to individual devices of the
19 matrix,

20 a second array of terminals for providing electrical connections to individual devices of the
21 matrix,

22 wherein the first array of terminals are electrically connected to the first metal layer and the
23 second array of terminals are insulated from the first metal layer and electrically connected
24 to the second metal layer by conductive channels which pass through and are insulated from
25 the first metal layer and device material.

26 56. A matrix of electronic devices according to claim 55, wherein the conductive channels
27 comprise metal plated channels.

- 1 57. A matrix of electronic devices according to claim 55, wherein the second array of terminals
2 are insulated from the first metal layer by a first layer of insulating material.
- 3 58. A matrix of electronic devices according to claim 57, wherein said first layer of insulating
4 material substantially covers said first layer of metal.
- 5 59. A matrix of electronic devices according to claim 57, comprising a third layer of metal
6 disposed on the first layer of insulating material and where said third layer is divided to
7 provide the first array of terminals and the second array of terminals.
- 8 60. A matrix of electronic devices according to claim 55, further comprising
9 a third array of terminals for providing electrical connections to the individual devices,
10 a fourth array of terminals for providing electrical connections to the individual devices,
11 wherein the fourth array of terminals are electrically connected to the second metal layer,
12 and the third array of terminals are insulated from the second metal layer and electrically
13 connected to the first metal layer by a second array of conductive channels which pass
14 through and are insulated from the second metal layer and material.
- 15 61. A matrix of electronic devices according to claim 60, wherein the second array of
16 conductive channels comprises metal plated channels.
- 17 62. A matrix of electronic devices according to claim 60, wherein the second array of terminals
18 are insulated from the second metal layer by a second layer of insulating material.
- 19 63. A matrix of electronic devices according to claim 60, wherein said second layer of
20 insulating material substantially covers said second layer of metal.
- 21 64. A matrix of electronic devices according to claim 63, wherein the fourth array of terminals
22 are electrically connected to the second metal layer by interconnects formed from through
23 said second layer of insulating material.
- 24 65. A matrix of electronic devices according to claim 60, wherein each of the array of second
25 conductive channels is provided at an end of each device of the matrix.

- 1 66. A matrix of electronic devices according to claim 65, wherein each of the array of first
2 conductive channels and second conductive channels are provided on opposing ends of
3 each device of the matrix.
- 4 67. A matrix of electronic devices according to claim 65, wherein the terminals are plated.
- 5 68. A matrix of electronic devices according to claim 65, wherein the terminals are plated with
6 nickel, copper and/or gold.
- 7 69. A matrix of electronic devices according to claim 55, wherein said insulating material
8 comprises a cured resin.
- 9 70. A matrix of electronic devices according to claim 55, wherein said at least one layer of
10 device material comprises alternating layers of device material and layers of metal.
- 11 71. A matrix of electronic devices according to claim 60, wherein said device is a PTC device
12 and said device material is a PTC material.
- 13 72. A stacked matrix comprising at least two matrices according to claim 60 which are stacked
14 on top of each other and in which corresponding terminals are electrically connected.